National Aeronautics and Space Administration

Astrophysics Probe Explorer (APEX) Solicitation

Pre-Proposal Conference
Technical, Management, and Cost (TMC)

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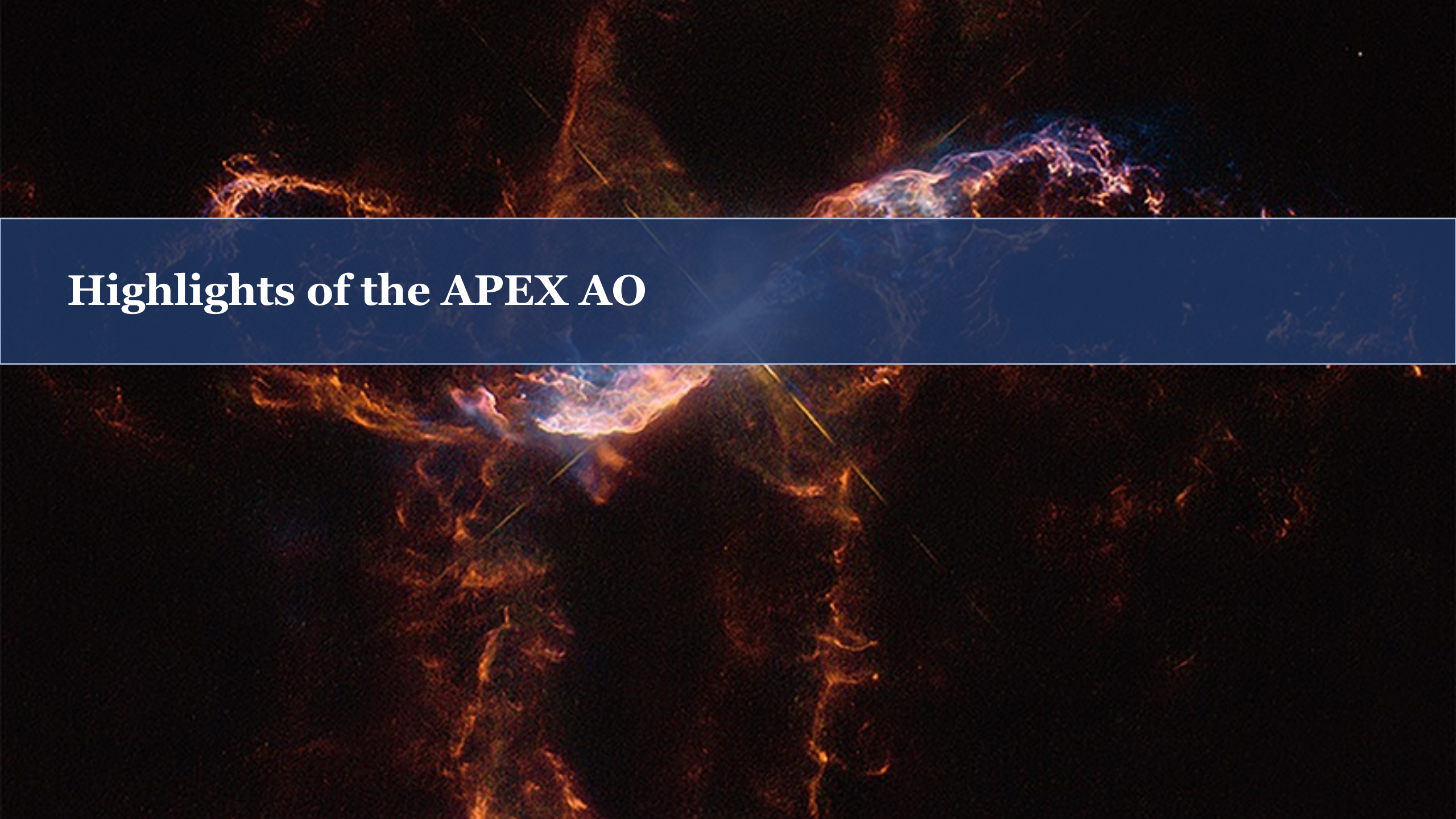
Outline

Glossary

AO	Announcement of Opportunity
APEX	Astrophysics Probe Explorer
GO	Guest Observer
LRD	Launch Readiness Date
NOI	Notice of Intent
PMW	Potential Major Weakness
PPC	Pre-Proposal Conference
S&MA	Safety & Mission Assurance
TMC	Technical, Management, and Cost
TRL	Technology Readiness Level



Highlights of the APEX AO

APEX AO Highlights

- APEX is soliciting PI-led missions; naming of PM and PSE are deferred to Step 2.
- This is Step 1 of a 2 Step Process. Phase A is funded at $5M (RY$) for missions that are selected.
- Missions selected from this AO are Category 2 projects (per NPR 7120.5F) with Class C payloads (per NPR 8705.4A) with a minimum mission duration of 5 years.
- Propose to an LRD of NLT July 2032.
- No option for technology demonstration opportunities (TDO).
- New SCaN language (also see SCaN presentation):
  - Missions proposed to be at 2 million kilometers or less and proposing to use NASA-managed space communication and navigation must not use the DSN for routine operations without proper justification.
  - Missions operating beyond GEO altitude and within 2 million kilometers of Earth shall be compatible with the Lunar Exploration Ground Segment (LEGS).

APEX AO Highlights

5.6 Cost Requirements and Constraints

- The PI-Managed Mission Cost is defined in Section 4.3.1 of the AO.
- The AO cost cap for an APEX mission is $1000 Million in Fiscal Year (FY) 2023 dollars, not including the cost of standard launch vehicle and launch services, or any contributions.
- Any launch services beyond the standard launch services and options offered must be funded out of the PI-Managed Mission Cost.
- The cost of SCaN recurring NSN per-minute/per-pass and/or DSN aperture fees must be included as a reduction to the adjusted AO cost cap
- Minimum unencumbered cost reserves against the cost to complete: 25% for Phases B/C/D, 25% unencumbered cost reserves on mission operations (WBS 1, 2, 3, 7, and 9) and 10% on the PI-led science investigation (WBS 4) for Phase E.

5.9.2 AO-Provided Access to Space

- An APEX investigation will be launched as the primary payload on a single launch vehicle. See Launch Vehicle Program Information Summary document in the Program Library for enveloping launch vehicle characteristics and capabilities.
- Launch vehicle options
  - High performance launch vehicle -$50M (cap decrease)
  - Extended fairing -$65M (cap decrease) – Requires high performance launch vehicle (included in $65M)

APEX AO Highlights

6.1.2 Notice of Intent to Propose

- To facilitate planning of the proposal evaluation process, NASA requires all prospective proposers to submit a Notice of Intent (NOI) to propose. (Due September 13, 2023)
- NOIs will help the evaluation teams to plan and secure the services of well qualified evaluators who do not have conflicts of interest earlier in the evaluation cycle.
- Include the names of as many team members as possible, including:
  - Any independent consultants used in developing the proposal
  - All participants on Red Team reviews or other major reviews used to provide the proposal team with independent reviews of the proposal prior to submission.
- SMD requests that proposers communicate any changes to the investigation team or intent to propose, between NOI and proposal submission, to the Astrophysics Probe Explorers Program Scientist identified in Section 6.1.5 of this AO.
- Submitting an NOI does not commit the team to submitting a proposal.

AO Simplification and Updates

AO Simplification Overview

- To reduce the workload on investigation teams generating Pre-Phase A proposals, NASA SMD has changed some requirements to be either deferred to Step 2 or simplified.
- Proposal evaluators will be directed to perform the evaluation based on these requirement deferrals, simplifications, and page reductions.
- The same simplifications seen in other recent AOs are also implemented for APEX.
- Deferral of requirements is meant to simplify proposal writing – not to waive any technical requirements.

Page count limits reflect the simplified requirements.

TMC Evaluation Criteria rewording reflects simplified requirements.

AO Template Simplification Details

Requirements simplified include:

- No paraphrasing of NASA Procedural Requirements (NPRs) needed; only any tailoring or waivers.
- Systems Engineering and Software Engineering: only aspects unique to the mission.
- Decision-making authority, teaming arrangement and responsibilities discussion brief. No need for explanation of traditional roles for key personnel, only mission-unique roles and responsibilities.
- Schedule: three schedule foldouts do not count against the page limit; an Integrated Master Schedule file is not required, only a Microsoft Excel table of dates.
- Tables for: Project risk and potential mitigations; Descopes; Basis of Estimate [Req. 58, 59, B-57]
- Brief discussions for cost: methodologies, assumptions, reserves, risk.
- No ‘exploded diagram’ in the appendix for Summary of Proposed Program Cooperative Contributions. International Participation reduced to tables and a brief narrative.
- Heritage Appendix page count limit is 15 pages.

AO Template Deferral Details

Discussions deferred to Step 2 include:

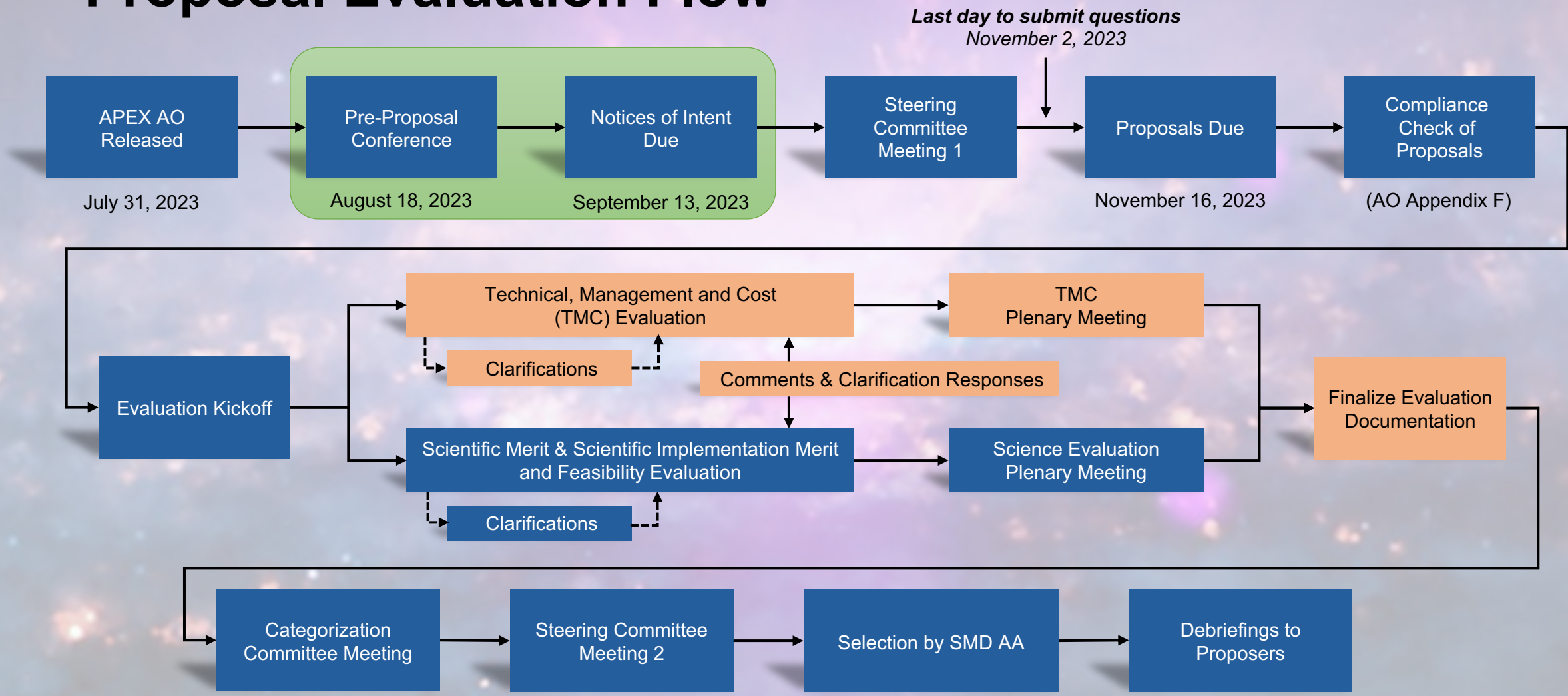
- Science Enhancement Option (SEO), Citizen Science, and Student Collaboration
- Independent Verification and Validation of Software
- RF maximum channel bandwidth
- Critical events coverage
- Non-AMMOS system use
- Ground system data flow diagram
- System Protection Plan
- Schedule-based end-to-end components of the Data Management Plan
- Names and resumes for Project Manager (PM) and Project Systems Engineer (PSE)
- Sources of estimate error and uncertainty in the proposed cost and management approaches for controlling cost growth
- Any independent cost estimates performed outside the proposing organizations
- Cost in Real Year dollars
- Description of cost estimate error and uncertainty
- Discussion of Limiting Orbital Debris and End of Mission Spacecraft Disposal Requirements

Other AO Changes

- Fraction of Cost incurred before KDP-C
  - The 25% maximum fraction of cost before KDP-C has been removed as a specific required limit, but proposers must state the fraction of PIMMC incurred prior to KDP C (Confirmation) and justify inclusion of cost elements that are beyond the scope of the Formulation phase
  - Project costs by phase are still expected to be consistent with the scope of work required in each project phase per NPR 7120.5. In particular, the project remains in Formulation and Technology Completion until successful KDP-C provides approval for transitioning into Implementation.
- Contribution Limit
  - The size and nature of contributions will be assessed as programmatic factors outside of the TMC,
  - Goal: ensure a preponderance of NASA interest in the investigation, as well as ensure that investigations of roughly comparable scope are proposed for purposes of equitable competition.
- Clarification for contributed letters of commitment: ~~No~~ Letters of Commitment are required for individuals in the Step-1 proposal~~, unless~~ where the individual's effort is contributed and the individual is part of the Proposal Team, collaborators excepted (see Q&A 28; this clarification and the inconsistency between this statement and section 5.5.7 will be corrected in an AO amendment by removing the reference to Co-Is in section 5.5.7)
- Space Communications and Navigation (SCaN) - See SCaN PPC presentation.
- No photographs allowed in any of the resumes
- Additional guidance provided for aligning WBS breakouts with those of the TMC cost validation effort
- Appendix J.13, Diversity and Inclusion Plan, is limited to 5 pages.

TMC Evaluation

Proposal Evaluation Flow



TMC Evaluation Overview

Proposal Evaluation Criteria

A. Science Merit of the Proposed Investigation

B. Science Implementation Merit and Feasibility of the Proposed Investigation

C. TMC Feasibility of the Proposed Mission Implementation

Weighting: The first criterion is weighted approximately 40%; the second and **third criteria are weighted approximately 30%** each.

TMC Evaluation: The purpose of the TMC evaluation is to assess the likelihood that the submitted mission or investigations' technical and management approaches can be successfully implemented as proposed, including an assessment of the likelihood of the completion within the proposed cost and schedule.

TMC Evaluation Factors

TMC evaluation factors are presented in the APEX AO, Section 7.2.4, “TMC Feasibility of the Proposed Mission Implementation”

- Factor C-1. Adequacy and robustness of the instrument implementation plan.
- Factor C-2. Adequacy and robustness of the mission design and plan for mission operations.
- Factor C-3. Adequacy and robustness of the flight systems.
- Factor C-4. Adequacy and robustness of the management approach and schedule, including the capability of the management team.
- Factor C-5. Adequacy and robustness of the cost plan, including cost feasibility and cost risk.

TMC Evaluation: What is Evaluated?

Total Risk of Science Flight Mission

Inherent Risks

Risks that are unavoidable to do the investigation:

- Launch environments
- Space environments
- Mission durations
- Unknowns
- *etc.*

Programmatic Risks

Risks that are uncertainties due to matters beyond project control:

- Environmental Assessment approvals
- Budgetary uncertainties
- Political impacts
- Late/non-delivery of NASA provided project elements
- Stability and reliability of proposed
- partners and their contributions
- *etc.*

Implementation Risks (Evaluated by TMC Panel)

Risks that are associated with implementing the project:

- Adequacy of planning incl. of the design
- Adequacy of management
- Adequacy of development approach
- Adequacy of schedule
- Adequacy of funding
- Adequacy of Risk Management (planning for known & unknown)

TMC Evaluation Purpose and Principles

Purpose: to assess the likelihood that the submitted investigations' technical and management approaches can be successfully implemented as proposed, including an assessment of the likelihood of their completion within the proposed project cost and schedule.

Basic Principles:

- It is assumed that the proposer is the expert on their proposal.
- Proposer's task is to demonstrate that the investigation implementation risk is low.
- TMC panel's task is to try to validate proposer's assertion of low risk.

Principles for Evaluation

- All proposals are to be treated fairly and equally.
- Merit and Risk are to be assessed on the basis of the material provided in the proposal and through the clarification process.
- Evaluation Ratings shall reflect the written strengths and weaknesses.
- Everyone involved in the evaluation process is expected to act in an unbiased objective manner; advocacy for particular proposals is not appropriate.

General Evaluation Ground Rules

- All proposals are evaluated to uniform standards established in the APEX AO, and without comparison to other proposals.
- All evaluators are experts in the areas that they evaluate.
- Specialist Evaluators (to provide special technical expertise to the TMC Panel) may be used based on need for expertise in a specific technology that is proposed.
- Proposals are based on pre-Phase A concepts; TMC risk assessments give appropriate benefit of the doubt to the Proposer.

TMC Evaluation Products: Findings

- **Major Strength:** A facet of the implementation response that is judged to be well above expectations and can substantially contribute to the ability of the project to meet its technical requirements on schedule and within cost.
- **Major Weakness:** A deficiency or set of deficiencies taken together that are judged to substantially weaken the project's ability to meet its technical objectives on schedule and within cost.
- **Minor Strength:** A strength that is worthy of note and can be brought to the attention of Proposers during debriefings, *but is not a discriminator in the assessment of risk*.
- **Minor Weakness:** A weakness that is sufficiently worrisome to note and can be brought to the attention of Proposers during debriefings, *but is not a discriminator in the assessment of risk*.

Note: Findings that are considered "as expected" are not documented as findings.

TMC Evaluation Products: Risk Ratings

Based on the narrative findings, each proposal will be assigned one of three risk ratings, defined as follows:

Low Risk: There are no problems evident in the proposal that cannot be normally solved within the time and cost proposed. Problems are not of sufficient magnitude to doubt the proposer's capability to accomplish the investigation well within the available resources.

Medium Risk: Problems have been identified, but are considered within the proposal team's capabilities to correct within available resources with good management and application of effective engineering resources. Investigation design may be complex and resources tight.

High Risk: One or more problems are of sufficient magnitude and complexity as to be deemed unsolvable within the available resources.

Note: Only Major findings are considered in the risk rating.

TMC Envelope Concept

Envelope: Contains all TMC Resources available to handle known and unknown development problems that occur. Includes schedule and funding reserves; reserves and margins on physical resources such as mass, power, and data; descope options; fallback plans; and personnel.

Low Risk: Required resources fit well within available resources.

Medium Risk: Required resources just barely inside available resources.

High Risk: Required resources DO NOT fit inside available resources.

TMC Panel Other Considerations

- The TMC panel can write comments to the Selection Official on topics relevant to programmatic considerations.
- While these comments will not be considered in the evaluation, they may be considered during selection.
- Examples include but are not limited to:
  - Size and nature of contributions,
  - Fraction of PIMMC expended before KDP-C,
  - Extent to which the proposed investigation provides career development opportunities to train the next generation of engineering and management leaders.
  - Appropriateness of the allocation of the additional data volume proposed for the potential Guest Observer (GO) data.

Clarification Process

Per APEX Evaluation Plan

Clarifications Process:

AO Section 7.1.1 states “Proposers should be aware that, during the proposal evaluation and selection process, NASA may request clarification of specific points in a proposal; if so, such a request from NASA and the proposer’s response must be in writing. NASA will request clarification in a uniform manner from all proposers.”

In particular, before finalizing the proposal evaluation NASA will request clarification on potential major weaknesses (PMWs) in the A, B, and C factors that have been identified in the proposal.

PIs whose proposals have no PMWs will be informed that no PMWs have been identified.

All PIs are allowed the same number of pages for Clarifications, including those who have no PMWs.

The full set of clarification responses to the factors above will be considered by the Science Panel and the Technical Management and Cost (TMC) panel. Only the responses will be provided to the other panel but not the PMWs.

Proposers will have at least 48 hours to respond.

Clarification Process Requirements
(1 of 3)

Clarifications Responses must conform to the following requirements:

Requirement 1: The clarification response shall consist of two documents: one Clarification Response Document that addresses the PMWs for the A and B factors (combined), and one Clarification Response Document that addresses the PMWs for the C-factors.

Requirement 2: Each Clarification Response Document shall be a single unlocked (*e.g.*, without digital signatures) searchable Adobe Portable Document Format (PDF) file, composed of the response text, figures, and/or tables. Images (*e.g.*, figures and scans) shall be converted into machine-encoded text using optical character recognition. Animations shall not be included. Links to materials outside of the response are not permitted. Comment fields shall not be inserted.

Requirement 3: The Clarification Response Documents shall be presented in 8.5 x 11 inch paper (or A4). Text shall not exceed 5.5 lines per vertical inch and page numbers shall be specified. Margins at the top, both sides, and bottom of each page shall be no less than 1 inch if formatted for 8.5 x 11 inch paper; no less than 2.5 cm at the top and both sides, and 4 cm at the bottom if formatted for A4 paper. Type fonts for text, tables, and figure captions shall be no smaller than 12-point (*i.e.*, no more than 15 characters per horizontal inch; six characters per horizontal centimeter). Fonts used within figures shall be no smaller than 8-point.

Requirement 4: For the A- and B-factors PMWs combined, the Clarification Response Documents shall not exceed eight pages. For the C-factor PMWs, the Clarification Response Documents shall not exceed six pages. Text, table(s) and figure(s) are permitted; however, all material shall be within the page limits specified above and shall abide by limitations in Requirements 2, 3 and 9. Each response file shall not exceed 10MB.

Clarification Process Requirements
(2 of 3)

Requirement 5: The Clarification Response Documents shall not contain International Traffic in Arms Regulations (ITAR), Export Administration Regulations (EAR), or classified material.

Requirement 6: The Clarification Response Documents shall label each PMW response with the PMW number provided. Each PMW clarification response shall contain only information specific to the PMW. A clarification response may point back to references in the proposal; however, PMWs' references to locations in the proposal indicate that they have already been evaluated and a re-reference alone does not obligate a re-consideration of those data. References to proposal material is expected to use the proposal section numbers and page number on the proposal page (as opposed to the electronic PDF file page number).

Requirement 7: The Clarification Response Document may include additional information on any criteria or requirements relevant to the proposed investigation (*e.g.,* for TMC Feasibility of the Proposed Investigation Implementation, advances in proposed technologies since proposal submission). However, this additional information counts against the total page limitation for the Clarification Response Document that contains it.

Requirement 8: The Clarification Response Document shall not include more than two new references in support of any single PMW clarification response or of any single additional information response. All references shall be to peer-reviewed literature, or to full conference proceeding papers (not just abstracts) that are published and accessible. References included in the proposal do not constitute new references. References shall be restricted to those with a publication or release date before the PMW sent date.

Clarification Process Requirements
(3 of 3)

Requirement 9: The clarification response may include, outside the two Clarification Response Documents, complete versions of a modified Science Traceability Matrix (STM; Table B1), Mission Traceability Matrix (MTM; Table B2), Total Mission Cost Profile table (Table B3 in Excel format), Master Equipment List (MEL; Table B5 in Excel format), and/or schedule foldout (AO Requirements B-49) and associated table of dates (AO Requirement B-50 in Excel format). These modified fold-out(s)/table(s) shall have modifications clearly marked by the use of a different color font or by a colored-bordered box (labeled "PMW Clarification"). The page-limited Clarification Response Documents shall provide the description of the updates and changes to the modified fold-out(s)/table(s) as text. The complete versions of the modified STM, MTM, Total Mission Cost Profile table, MEL and schedule will not count against the page limit. Any new or other fold-out(s) will each count as two pages against the response page limit.

TMC Cost Analysis

Cost Analysis Overview

- Cost is one important element of Technical, Management and Cost (TMC).
- Initial cost analyses are performed on the basis of information provided in the proposals

  (*e.g.*, technical baseline, schedule, WBS, cost consistency and completeness, basis of estimate, contributions, use of full cost accounting)
- Cost models for TMC Base Independent Cost Estimates ("base ICE")
  - Two or more cost models are used to validate the proposed cost for Phases B-D. One or more for Phase E.
  - Cost Models are chosen to be complementary to each other, when possible, *i.e.,* different modeling approaches.
  - For Step 2 evaluations, more cost models may be used.
  - Cost model inputs are obtained from the information in the Proposal in order to develop the TMC ICE for the project "as proposed".
- The TMC identifies implementation threats (weaknesses) and assigns Cost Threats where applicable.
  - Cost Threats are estimates of the cost to mitigate the identified threat and the likelihood that the mitigation will be needed. The total of all Cost Threats above a selected threshold are compared to the proposed unencumbered reserves.
- The entire panel participates in Cost deliberations. All information from the entire evaluation process is considered in the final cost assessment.

Decoding Cost Validation MW

- A cost validation Major Weakness can take the following form:

A sum of cost elements over which the selected cost model(s) are validated against actuals.
Typically can be:
- WBS 1+2+3
- WBS 5
- WBS 6+10
- Total Phases B-D
- Total Phase E

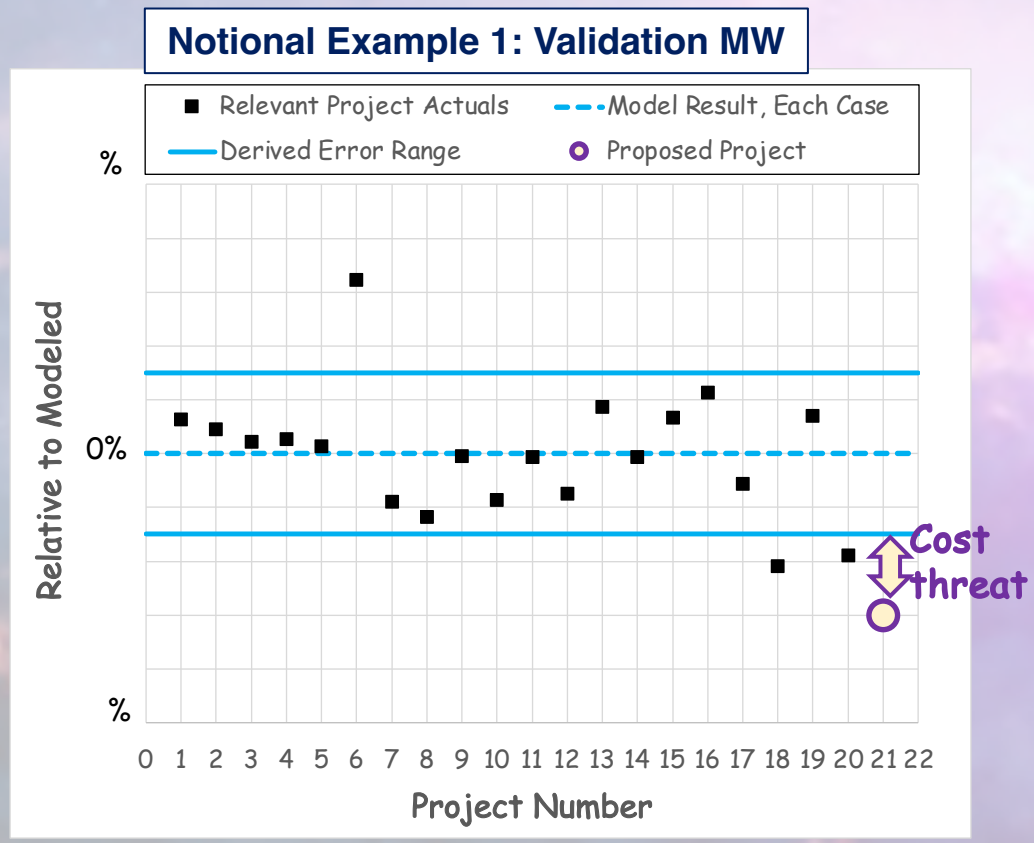
The proposed costs for WBS X.XX cannot be validated, as the TMC Base Independent Cost Estimate exceeds the proposed cost by more than the error range.

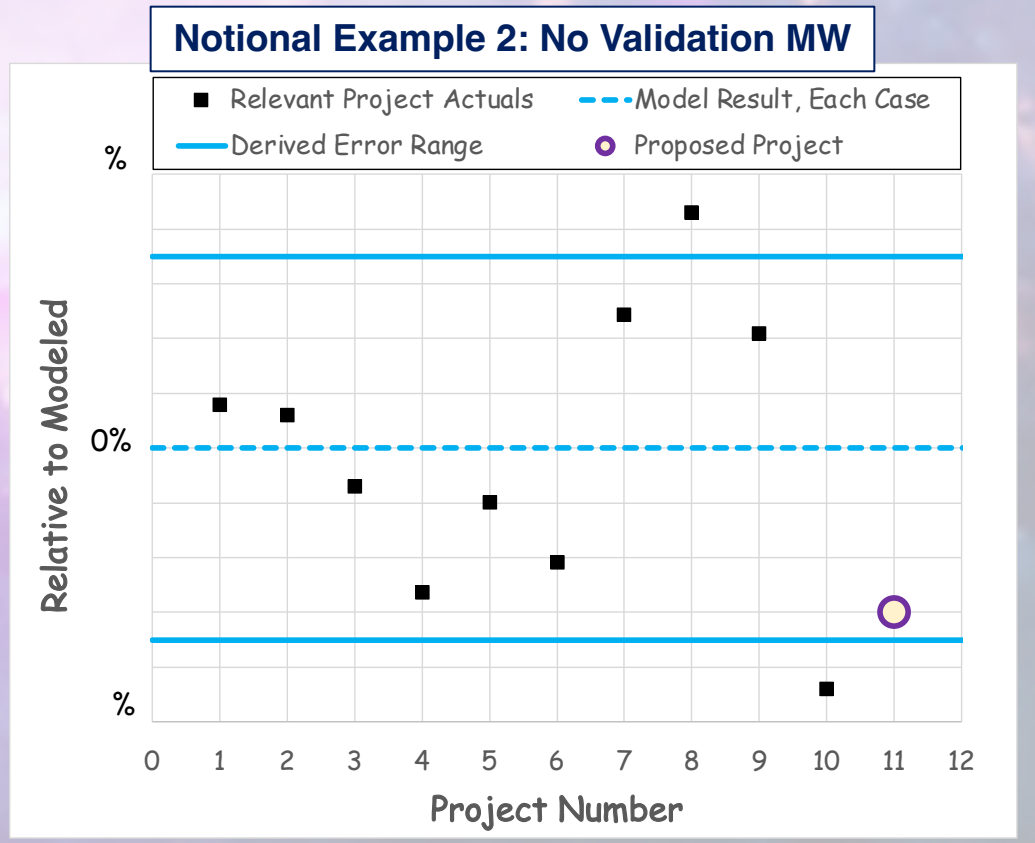
The TMC Base ICE:
- combines the results of the models used (no reserves)
- is performed with the best performing models selected after testing several models against past actuals relevant to this acquisition
- follows the same process, for all proposals in this acquisition
- uses inputs that are based exactly on information in the proposal (*incl.* MEL, schedule, heritage, TRL, cost BOE, *etc.*)

A specific error range is:
- defined prior to the start of proposal evaluations
- derived for this acquisition and each WBS group
- applied to the TMC Base ICE
- based on the combined performance of the selected models on past actuals relevant to this acquisition

Notional Validation Error Bar Example

- How large a difference from the cost model is needed to trigger a validation finding?
- It depends on how well the chosen cost model combination validates against actuals of relevance, statistically.

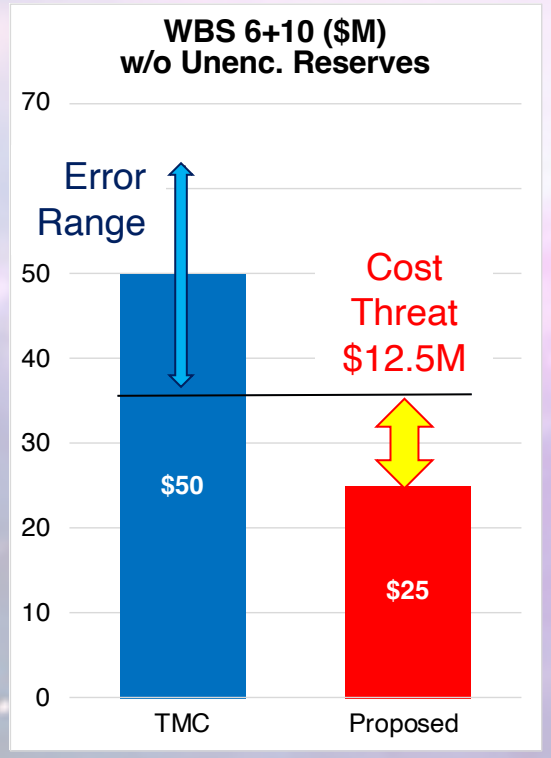




Decoding Cost Validation MW: Example

Notional Proposal A: validates

Notional Proposal B: does not validate



- The situation shown in notional example A would not result in a validation finding.
- The situation shown in notional example B would result in the following finding:

"The proposed costs for the sum of WBS 6 and 10 cannot be validated, as the TMC Base Independent Cost Estimate exceeds the proposed cost by more than the error range. "

…followed by a cost threat statement.

Cost Threat Matrix

- The likelihood and cost impact, if any, of each weakness is estimated then stated in terms of Likelihood and Impact categories
  - The **likelihood** is the probability range that the cost impact will materialize.
  - The **cost impact** is the current best estimate of the range of costs to mitigate the threat.
- The cost threat matrix defines the adjectives that describe the likelihood and cost impact.
- The minimum cost threat is $2M for Phases B/C/D *and $1M for Phase E*.

				Cost Impact (CI) **% of PI-Managed Mission Cost to complete Phases B/C/D or *% of Phase E*** **not including unencumbered cost reserves or contributions**				
	Likelihood of Occurrence	**Weakness**	**Very Minimal** $2M < CI ≤ 2.5% *$1M < CI < 2.5%*	**Minimal** 2.5% < CI ≤ 5% *2.5% < CI ≤ 5%*	**Limited** 5% < CI ≤ 10% *5% < CI ≤ 10%*	**Moderate** 10% < CI ≤ 15% *10% < CI ≤ 15%*	**Significant** 15% < CI ≤ 20% *15% < CI ≤ 20%*	**Very Significant** CI > 20% *CI > 20%*
Likelihood (L, %)	Almost Certain (L > 80%)							
	Very Likely (60% < L ≤ 80%)							
	Likely (40% < L ≤ 60%)							
	Possible (20% < L ≤ 40%)							
	Unlikely (L ≤ 20%)							

Decoding Cost Threat Statement

- When a Cost Threat is associated with a Major Weakness, the cost threat statement takes the following form:

Estimated likelihood of the cost threat being realized:
- Unlikely: < 20% (weight 10%)
- Possible: 20% - 40% (weight 30%)
- Likely: 40% - 60% (weight 50%)
- Very Likely: 60% - 80% (weight 70%)
- Almost Certain: > 80% (weight 90%)

This finding represents a cost threat assessed to have a [LIKELIHOOD] likelihood of a [IMPACT] cost impact being realized during development and/or operations, which results in a reduction from the proposed unencumbered cost reserves.

Estimated magnitude of the cost threat relative to the proposed cost (PIMMC in that phase):
- Very minimal: 0.5% – 2.5% (subject to lower $ threshold)
- Minimal: 2.5% - 5%
- Limited: 5% - 10%
- Moderate: 10% - 15%
- Significant: 15% - 20%
- Very Significant: > 20%

(Can be a specific estimate or middle of the range)

Phase affected by cost threat
- Cost threat impact ranges established separately for Phases B-D and Phase E
- Cost threats evaluated separately against Phases B-D and Phase E
- Impact of cost threats on reserves applied separately to Phases B-D reserves and to Phase E reserves

If realized, cost threats would consume unencumbered cost reserves
- By definition, TMC-identified cost threats are above and beyond the proposed cost basis and the proposed encumbered cost reserves

Decoding Cost Threat Statement: Examples

Example of cost threat statement 1: cost validation Major Weakness

- The cost validation process results in a cost threat of $12.5M for WBS 6+10. The notional example PIMMC for Phases B-D is $100M.
- The TMC ponders the case made in the proposal for cost-reducing paradigm and gives further benefit of the doubt to the proposer. The likelihood of this cost threat is estimated in the range 20%-40%.
- The TMC appends the following statement to the cost validation MW:

> *This finding represents a cost threat assessed to have a **Possible** likelihood of a **Moderate** cost impact being realized during **development**, which results in a reduction from the proposed unencumbered cost reserves.*

Example of cost threat statement 2: technical Major Weakness

- The TMC considers that the Technology Readiness Level (TRL) is overstated and that it is likely that a TRL development plan will be required before KDP-C. The notional example PIMMC for Phases B-D is $100M.
- The TMC estimates that the cost for an adequate TRL development plan would be in the range of $2.5M to $5M
- The TMC writes the technical MW and appends the following statement:

> *This finding represents a cost threat assessed to have a **Likely** likelihood of a **Minimal** cost impact being realized during **development**, which results in a reduction from the proposed unencumbered cost reserves.*

Decoding Summary Statement

Cumulative impact of cost threats

- The Form C "Overall Evaluation/Rationale" Summary could include a statement of the following form.
- When present, this statement informs the risk rating, together with all of the Major Findings. This statement alone does not automatically result in any specific rating.

Example (could also be Phase E)

Subtract total from the total proposed unencumbered cost reserves in that phase

Applies to unencumbered only. (Encumbered reserves are already assigned to other, specific risks.)

The TMC-identified cost threats reduce the Phases B–D unencumbered cost reserves below the 25% required by the AO.

Total of all identified threats
- weigh impact by likelihood
- add %unencumbered reserves required by the AO (25% for Phases B-D, 15% for Phase E)

TMC compares remaining to AO-required %
- An informational statement
- TMC also assesses the appropriateness of the proposed %unencumbered cost reserves for the specific proposed scope, as justified by the proposal

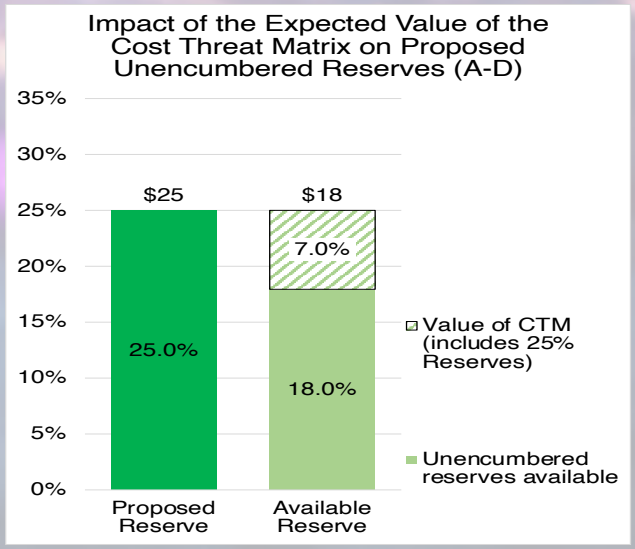
Decoding Summary Statement: Example

Example of cumulative impact (notional)

- The cumulative impact of the cost threats for this notional example brings the unencumbered cost reserves level from the proposed level of 25% down to 18%.

Likelihood of Occurrence	Weakness	Cost Impact (CI) % of Baseline Mission Cost to complete Phases B-D not including unencumbered cost reserves or contributions					
		Very Minimal $1.0M<CI≤2.5% ($1M<CI≤$2.5M)	Minimal 2.5%<CI≤5% ($2.5M<CI≤$5M)	Limited 5%<CI≤10% ($5M<CI≤$10M)	Moderate 10%<CI≤15% ($10M<CI≤$15M)	Significant 15%<CI≤20% ($15M<CI≤$20M)	Very Significant CI>20% (CI>$20M)
AlmostCertain (L>80%)							
VeryLikely (60%<L≤80%)							
Likely (40%<L≤60%)	TRL Maturation		$1.9				
Possible (20%<L≤40%)	Cost Validation		*$3.75M x 50% = $1.9M*		$3.7		
Unlikely (L≤20%)							

Example for Phases B/D	
PIMMC without unenc. reserves	$100.0
Proposed unenc. reserves %	25%
Proposed unenc. reserves	$25.0
Total expected cost threat impact	$5.6
Reserves % on cost threats	25%
Total impact of cost threats	$7.0
Proposed unenc. reserves minus expected cost threats	$18.0
Proposed unenc. reserves minus expected cost threats %	18.0%



Clarification of Cost PMWs

The Clarification process offers a chance for updating cost information

Information from proposers provided during clarifications may be relevant to cost threat statements associated with PMWs.

For example, the following types of information may be folded into the cost analysis even after the clarifications.

- Past actuals for efforts justified as being similar or otherwise relevant.
- References to past efforts justified as being similar, for which past actuals in CADRe exist.
- Further basis of estimate details, for the specific area(s) identified in the PMW.
- Resolution of inconsistencies or clarification of any misunderstanding affecting cost model inputs.

Benefit of the Doubt in Cost Validation

The TMC Cost Validation process has been geared in several ways towards providing proposers the benefit of the doubt.

1. The inputs to the cost models are derived directly from the descriptions in the proposal, "as proposed"
   - This includes all heritage and TRL level claims.
   - TMC's independent assessment of technical parameters, if it differs from that of the proposal, is not factored into the Base ICE. It would be reflected in separate findings, with associated cost threats if applicable.
2. Validation error bars are derived specifically for each solicitation. They reflect how well the selected cost model combination performs against actuals of relevance to the solicitation.
   - A cost validation finding major weakness is written only if the proposed cost is outside that error bar.
3. The validation cost threat impact only reflects excursions outside of the error bar (not the full delta between modeled and proposed).
4. The validation cost threat impact is weighted by the cost threat likelihood.
5. Proposal and clarification content can affect the likelihood of the validation cost threat.

Evaluation of the Cost Basis of Estimate

- AO Req. B-57 describes requirement for the Basis of Estimate (BOE):
  - Traceable to the WBS of Table B3 (at the WBS level that best explains the BOE)
  - Description of the methodologies and assumptions used to develop the proposed cost estimate,
  - Description of cost reserves that provides insight into their adequacy and robustness,
  - Any additional BOE data to assist the validation of the cost estimates.
- The type of data useful to support a BOE depends on the method used for the cost estimate
  - Example if based on analogy: list heritage cost and rationale for adjustments
  - Example if using parametric model: model name and version, key inputs used with rationale
  - Example if using bottom-up estimates: breakout of labor vs material, FTEs and/or WYEs and average labor rates, list of significant hardware with date and importance to investigation.
- No external independent cost validation estimates are expected in the proposal, nor are they evaluated or considered if submitted.
- TMC's evaluation of the quality of the proposer's basis of estimate is separate from TMC's ICE analysis.
- Different findings can result from the BOE and from the ICE. If the findings are Major, they are both considered during polling for the final risk rating.

Cost Validation Lessons Learned

Proposal teams who do the following tend to better support their proposed cost

- Estimate both schedule and cost iteratively, starting early in proposal development; let that inform the proposed scope.
- Estimate both schedule and cost conservatively by accounting for remaining unknowns and for expected cost growth during proposal development and during Phase A.
- Identify cost-driving parameters clearly and consistently (including TRL, modifications from heritage, engineering models & spares, *etc.*)
- Use NASA Standard WBS definitions and terminology.

Cost Threats Lessons Learned

Proposal teams who do the following tend to better support their proposed reserves posture

- Apply risk management process early; plan mitigations appropriate for the proposed project class.
- Encumber appropriate amounts of cost reserves against those risks that could impact schedule and/or cost.
- Determine the levels of funded schedule reserve and of unencumbered cost reserves that would be adequate and robust for the proposed project –as well as their phasing.
  - Unencumbered cost reserves higher than the minimum AO requirement, and funded schedule reserves higher than typical practices, may be necessary for some elements of some projects, such as those requiring specific technology maturation.
  - Remember to also carry unencumbered cost reserves against the encumbered cost reserves; encumbered cost reserves are part of the base PIMMC.
- Remember that appropriate cost reserves could be either the minimum required by the AO, or higher as assessed by the TMC evaluation panel based on the justification provided by the proposal.

Additional Information on Cost Estimation

- NASA WBS Handbook in the Program Library https://explorers.larc.nasa.gov/2023APPROBE/pdf_files/NASA03.%20NASA%20SP-3404%20WBS%20Handbook.pdf

- NASA Cost Estimating Handbook: https://www.nasa.gov/content/cost-estimating-handbook

- Note that several NASA cost models that may be relevant to some projects are free to proposers and do not require cost expert training (spreadsheet-based and compatible with Mac and PC). These include:
  - Project Cost Estimating Capability (PCEC)
  - NASA Instrument Cost Model (NICM)
  - Mission Operations Cost Model (MOCET)

  Access can be requested at https://software.nasa.gov/software/category/all/aw/1/cost.

  Use of these models is not a requirement nor an expectation.

References

APEX AO Reference Material

APEX Acquisition Home Page

The APEX acquisition home page is available at

https://explorers.larc.nasa.gov/2023APPROBE/

The contents of the web site include the following:

- Community announcements and APEX AO news
- Links to the APEX AO and to SAM.gov
- APEX AO Q&As
- Evaluation Plan
- Preproposal conference materials
- Teaming interest

APEX AO Reference Material

APEX Program Library

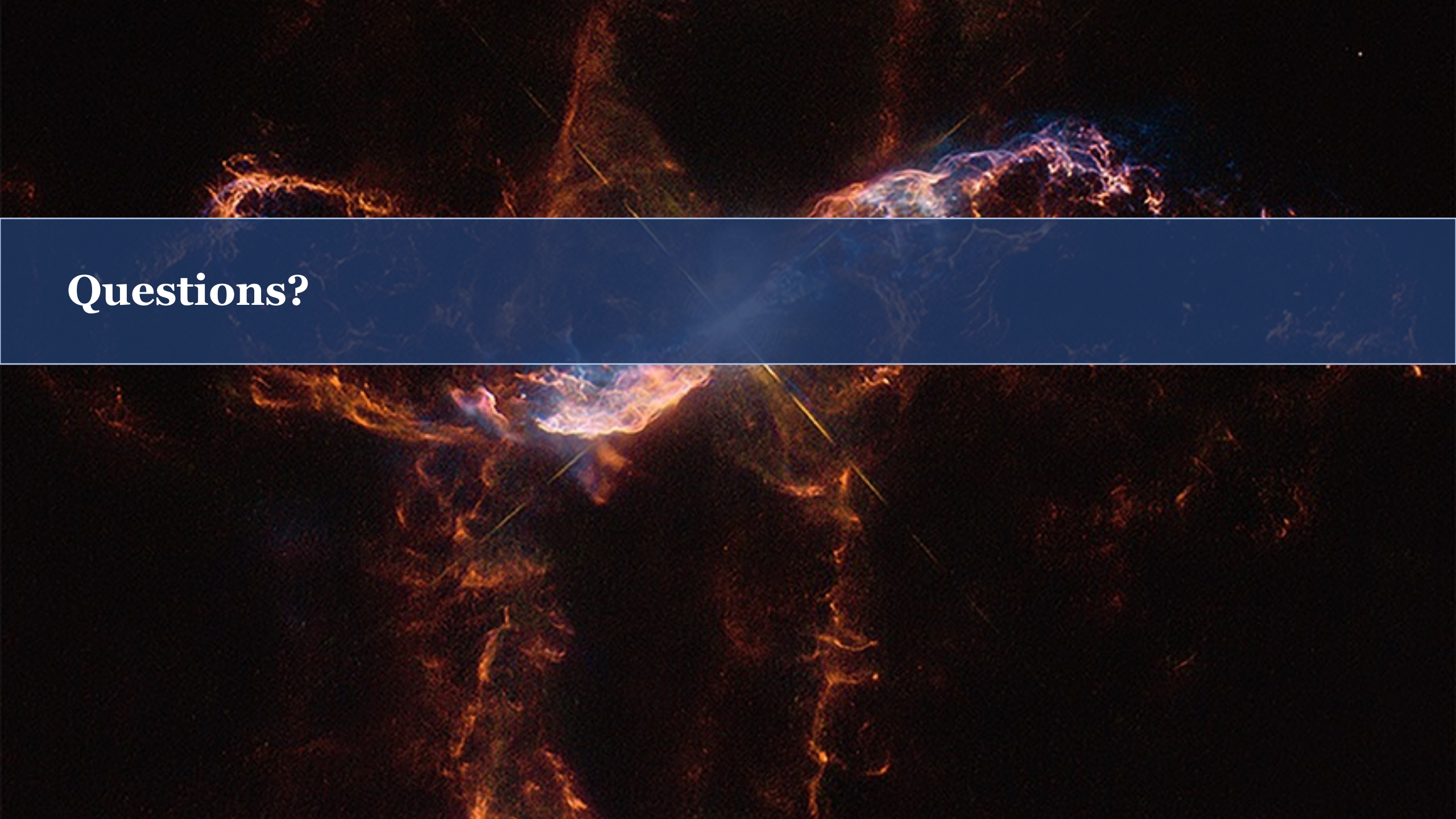
- The Library provides additional regulations, policies, and background information. The Library is accessible at https://explorers.larc.nasa.gov/2023APPROBE/programlibrary.html
- It is incumbent upon the proposer to ensure that the documents used in proposal preparation are of the date and/or revision available in the Program Library.

Questions and Answers (Q&As)

- Link to Q&As is on the Acquisition Homepage
- Questions are welcome up to 14 days before proposal due date (November 2nd).
- Questions are anonymized before publication on the web page.
  - The Evaluation Panels are not made aware of what proposers originated which questions.
- Publication ensures that all proposers have equal access to the same information.

TMC Evaluation

- **Common Causes of Major Weaknesses References**
- Technology Readiness Level:
  - *Assessment of TRL in AO-Based Evaluations and Common Causes of Major TRL Weaknesses*
  - Located in Program Libraries
- Management:
  - *Common Management Major Weaknesses in Step One Proposals*
  - Located at SOMA website: https://soma.larc.nasa.gov/tmcII/ManagementFindingsStudy-to-post-R3.pdf


Questions?

All further questions pertaining to the APEX AO

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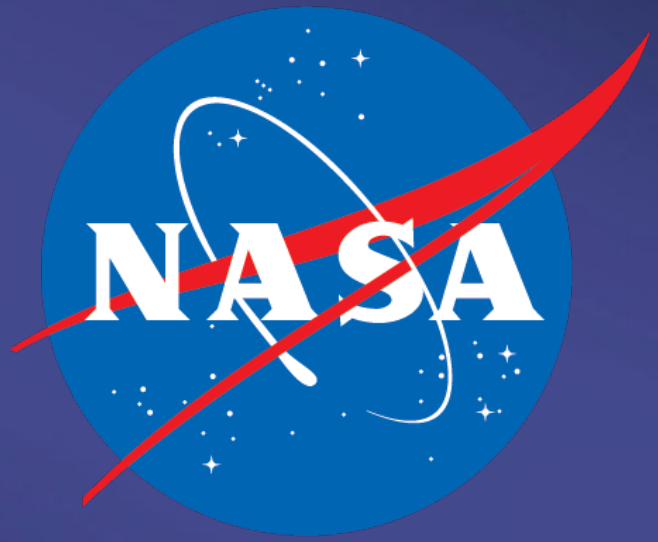
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